Technological Developments

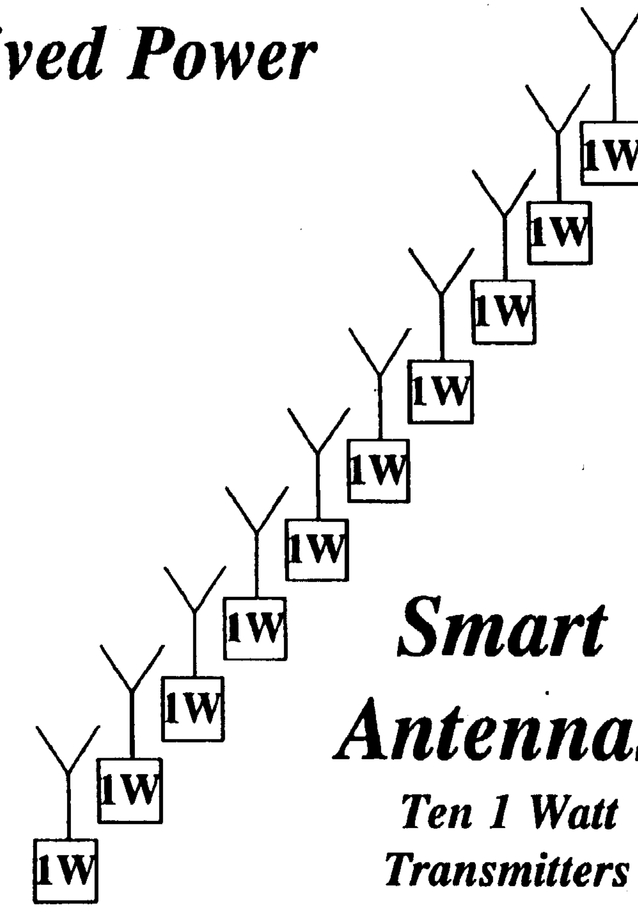
Smart Antenna Power Efficiency

Same Received Power

Conventional

100 W

One 100 Watt transmitter has higher total power consumption and total cost



Smart Antennas

Ten 1 Watt Transmitters

Technological Developments

Smart Antennas and Internet Access

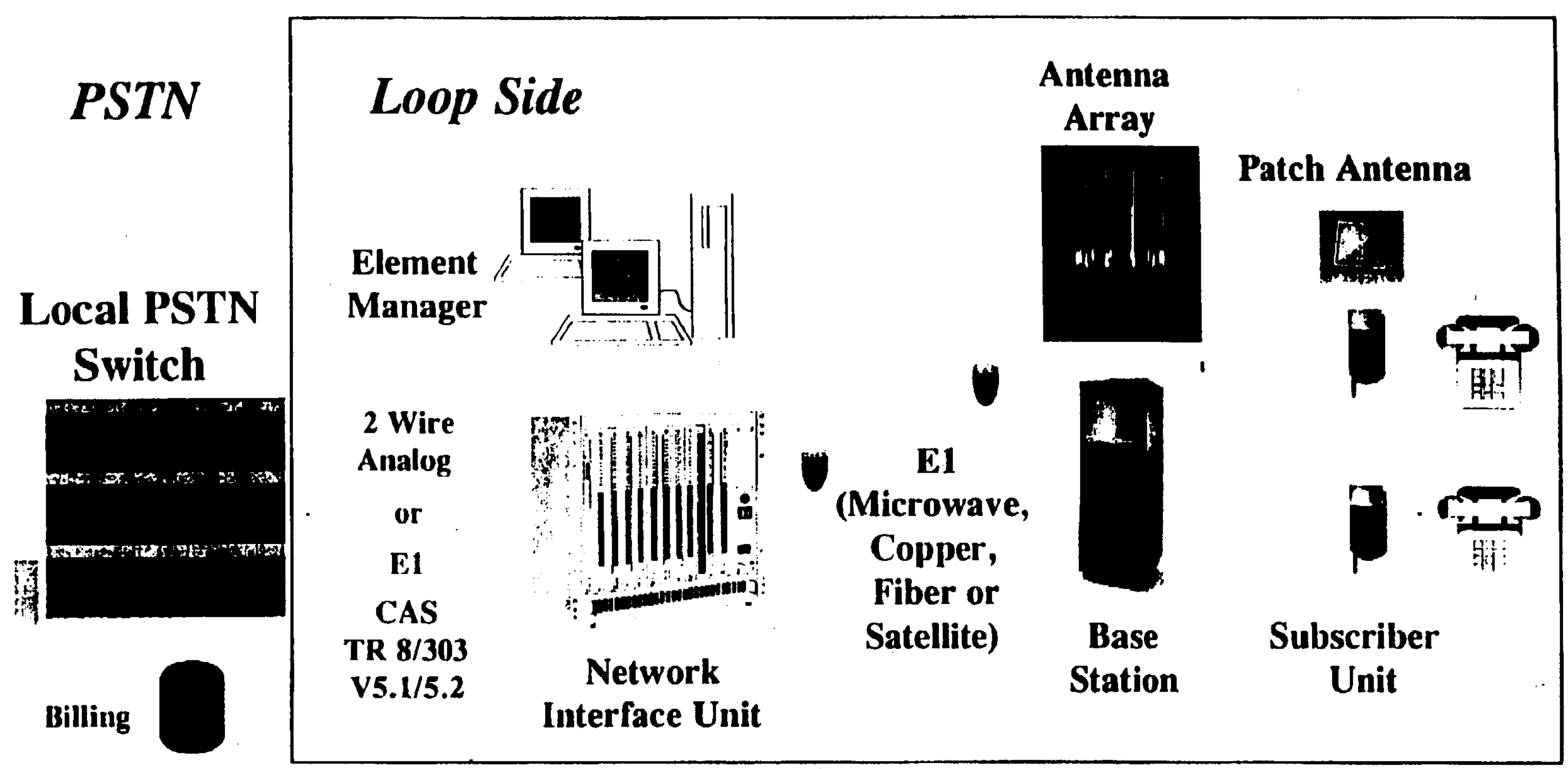
- Wireless Support for Packet Data More Difficult than for Voice!
  - Higher instantaneous bandwidth per user
  - More stringent data quality requirements
  - More dynamic and unpredictable interference
- Implications
  - Conventional systems will have poorer frequency reuse as compared with similar data rates for voice
  - Interference mitigation is most critical
  - Smart antennas will be indispensable for supporting Internet access

Technological Developments
PHS/Smart Antenna Case History

- **The Market**
  - PHS is a 1.9 GHz public cordless service and a leading alternative to having a second line in the home in Japan
  - Price is comparable to payphone call (<$0.10 per minute)
  - 7 million PHS subscribers in 2 years from launch
- **DDI Pocket Telephone, Inc.**
  - First wireless operator to widely deploy smart antennas
  - Serves 55% of the market (and 70% of the traffic) among 3 operators, with one-seventh the number of base stations
  - Became profitable in 2 years, 3 months from launch
  - 32 kbps data service now accounts for >20% of traffic and is fastest-growing segment (64 kbps data available Q2'99)

WLL Solutions
System Architecture

Enhanced Cordless WLL (employing smart antennas)



WLL Solutions

Technology Description

- Base station (with smart 12-antenna array), fixed subscriber unit, network interface unit and element manager
- Frequency band: 1880-1920 MHz (Re-tunable)
- Access method: TDMA (300 KHz spacing, 8 timeslots/carrier)
- Duplex method: Time division duplex (TDD)
- Voice encoding: 32 kbps ADPCM
- Modulation: p/4 DQPSK
- Telephony-transparent on switch and CPE sides
- Transparently supports PSTN class 5 services
- Voiceband data and G.3 fax supported
- Data option for 64 kbps clear channel
- Single, multiline and payphone subscriber units

WLL Solutions
Other Technology Enhancements

- Bi-directional Closed Loop Power Control
- Signaling optimizations for fast call setup
- Over air software download and OMC
- Timing advance and equalization

WLL Solutions

Deployability

- Dynamic channel allocation
  - no frequency planning
  - self-synchronizes and self-organizes system resources
- Smart Antennas
  - adapt to interference, changes in the environment, etc.
  - no special installation, matching or precision antenna engineering (or re-engineering) required
- "Software" Radio
  - comprehensive remote monitoring, diagnostics, etc.
  - remotely software upgradeable

WLL Solutions

Rural Infrastructure/Implementation Issues

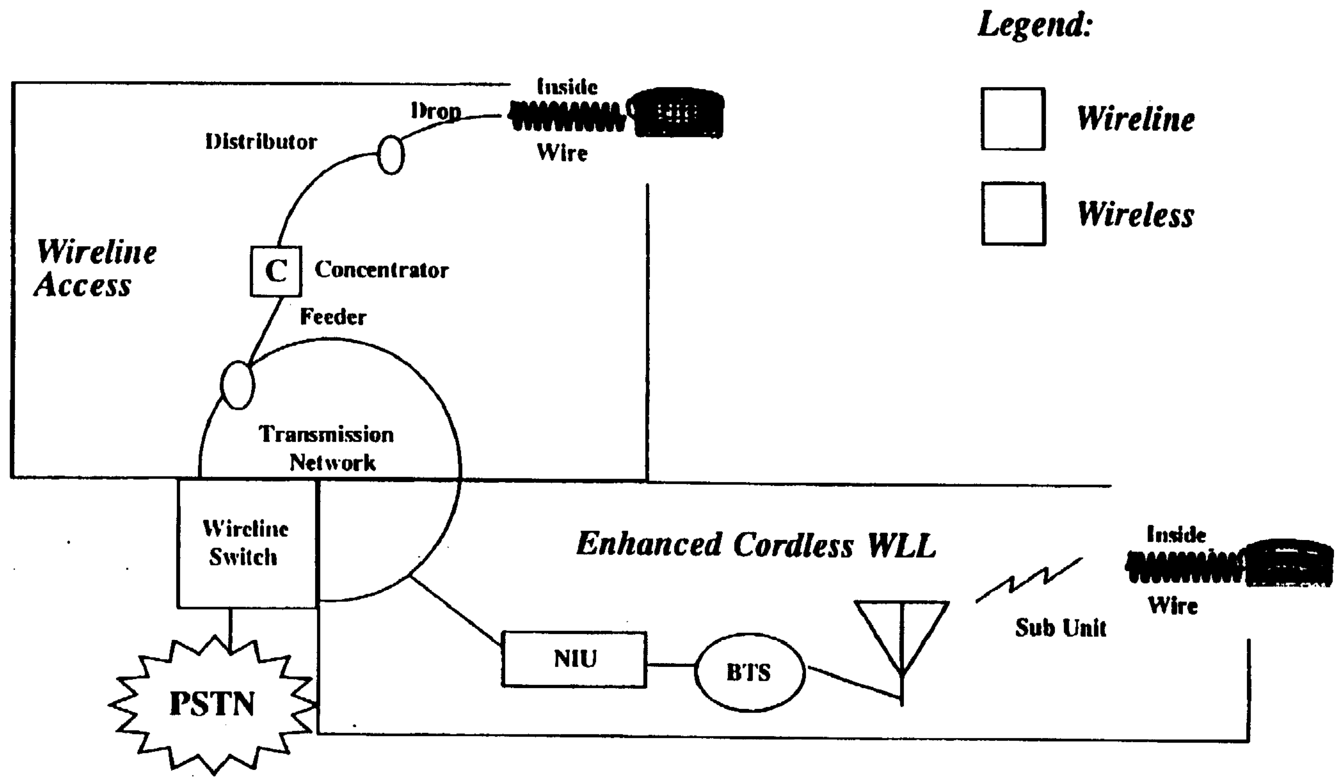
- Network backbone alternatives
  - microwave
  - satellite
- Shelters (to control environmental and security)
  - existing structures, where feasible
  - new/dedicated, where necessary
- Alternative Power (for autonomy or backup)
  - solar
  - wind

Economics
Brazil Study - Overview

- Turnkey installation from subscriber phone to the central office (no switch)

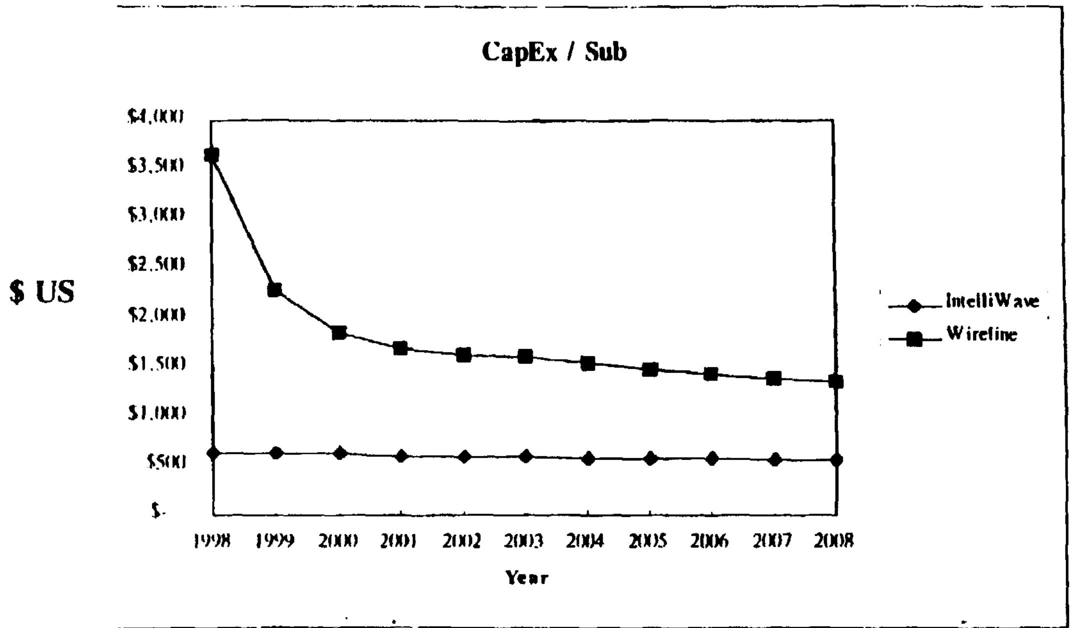
Wireline Technology	Twisted Pair
Wireless Technology	Enhanced Cordless WLL
Population of Service Area (000)	17,000 (mixed urban to rural)
Growth Rate	0.5%
Penetration (Total Lines/Total Population)	
Year 1	24.5%
Year 10	41%
Tariff	
Monthly Fixed Costs	$ 13.00
Price/Minute	$ 0.06
Minutes of Use (MOU) per subscriber	350 per month
Network Deployment Time	4 Years WLL, 6 Years Wireline

Economics
Brazil Study - Network Reference Diagram



ArrayComm Proprietary and Confidential

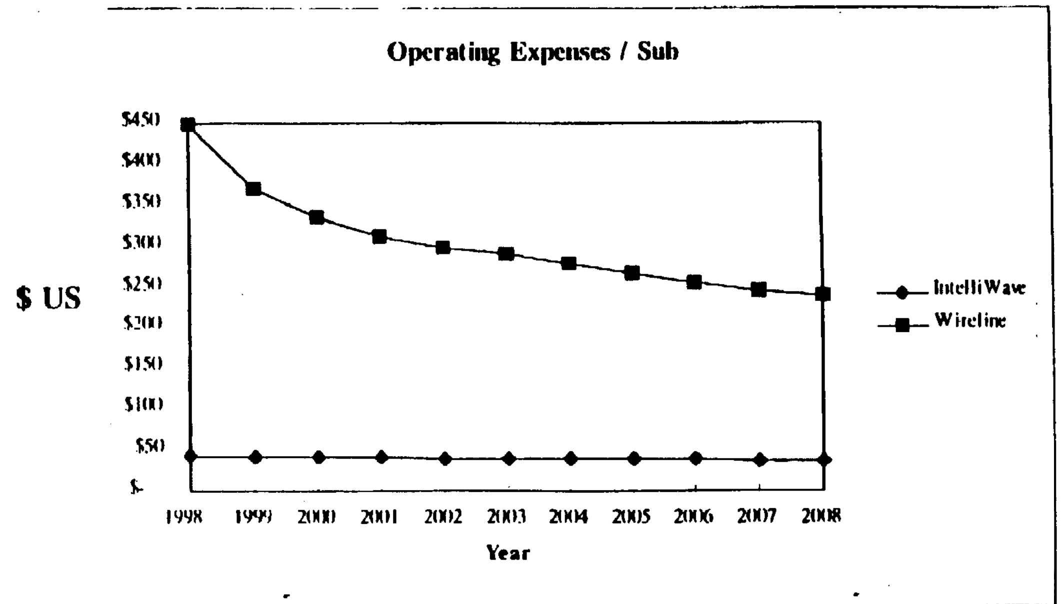
Economics
Brazil Study - Capital Expenditure / Sub



WLL technology not only requires less network investment than a wireline network, but also scales with subscriber growth, reducing financial risk.

Economics

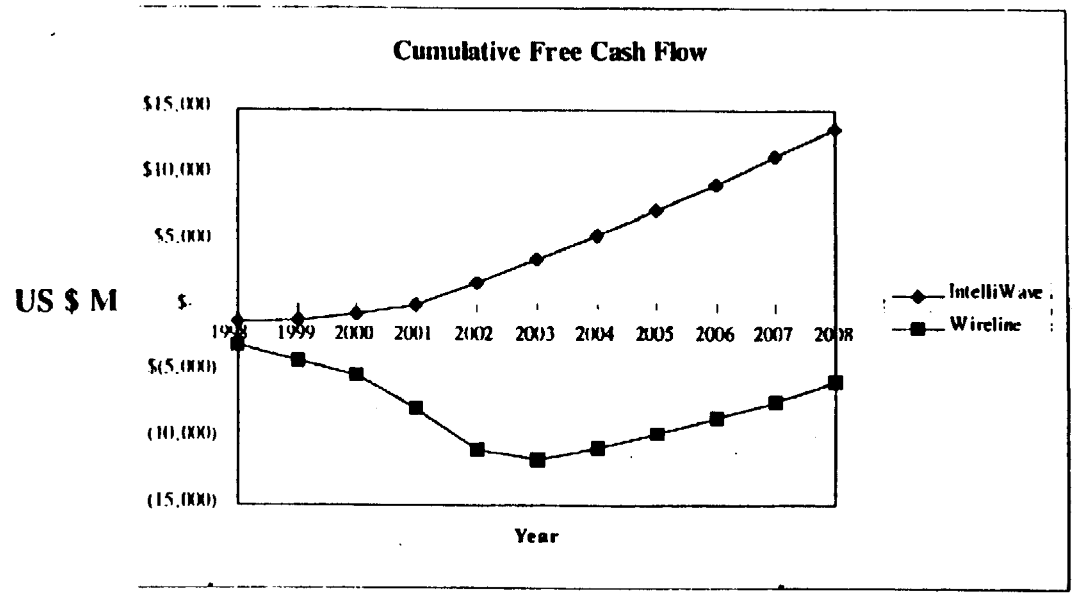
Brazil Study - Operating Expense / Subscriber



Network operating expenses are five times as much for a wireline network.
This greatly reduces working capital needs, resulting in greater valuation.

Economics

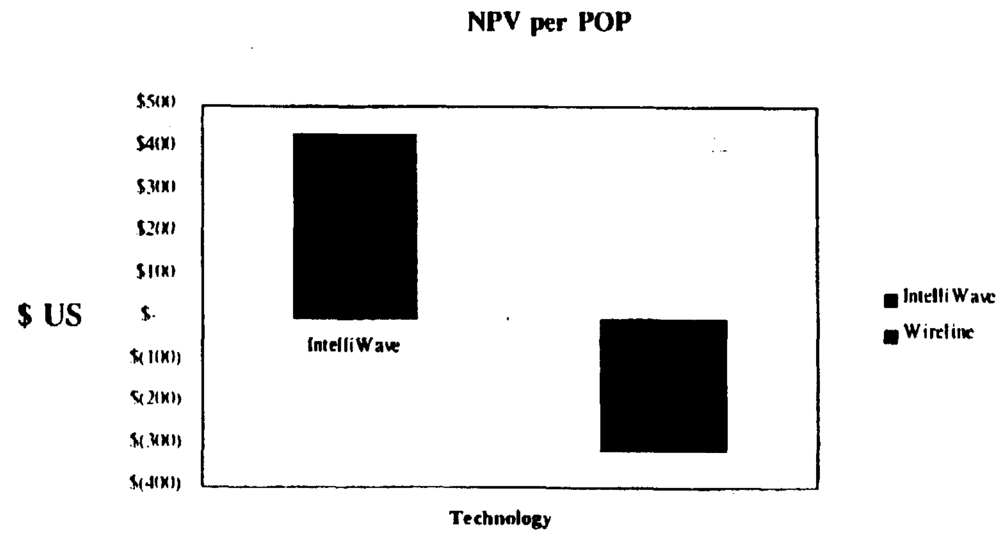
Brazil Study - Peak Funding



The operator recoups investments by Year 3 in the WLL case while this would not occur in the first 10 year in the wireline scenario.

Economics

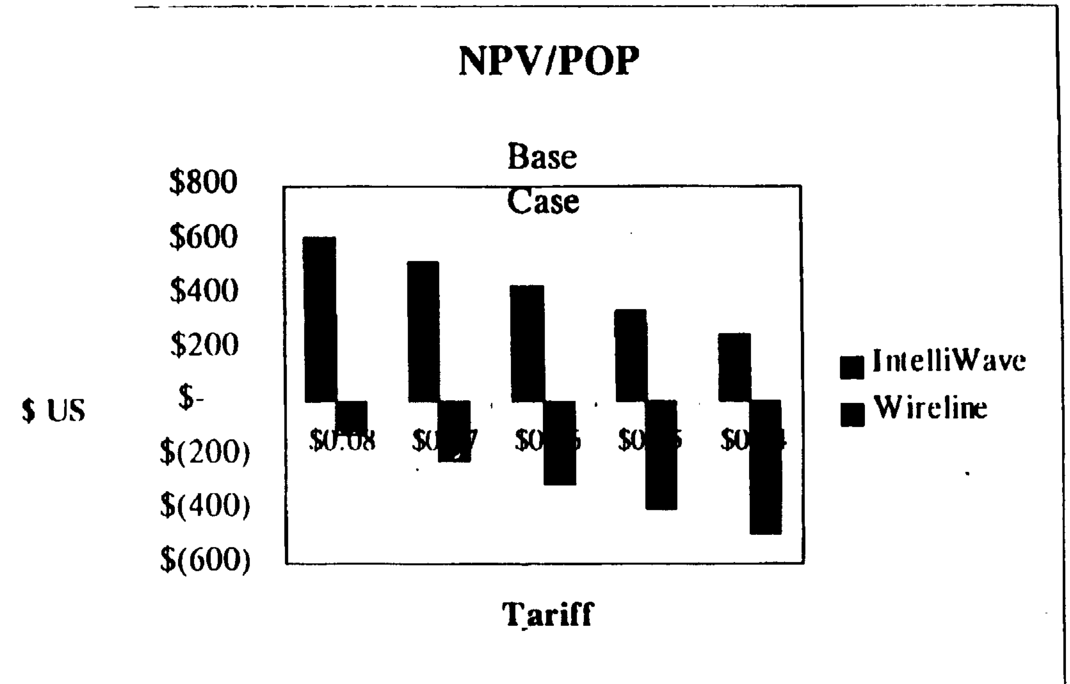
Brazil Study - Net Present Value (NPV) / POP



The Enhanced Cordless WLL network would generate much greater value than the wireline network. ($433 NPV vs. $ -241 NPV/POP)

Economics

Brazil Study - Tariff Sensitivity



While the wireline network is a poor investment if tariff forecasts are not achieved, the Enhanced Cordless system still provides high value.

Economics
Brazil Study - Summary

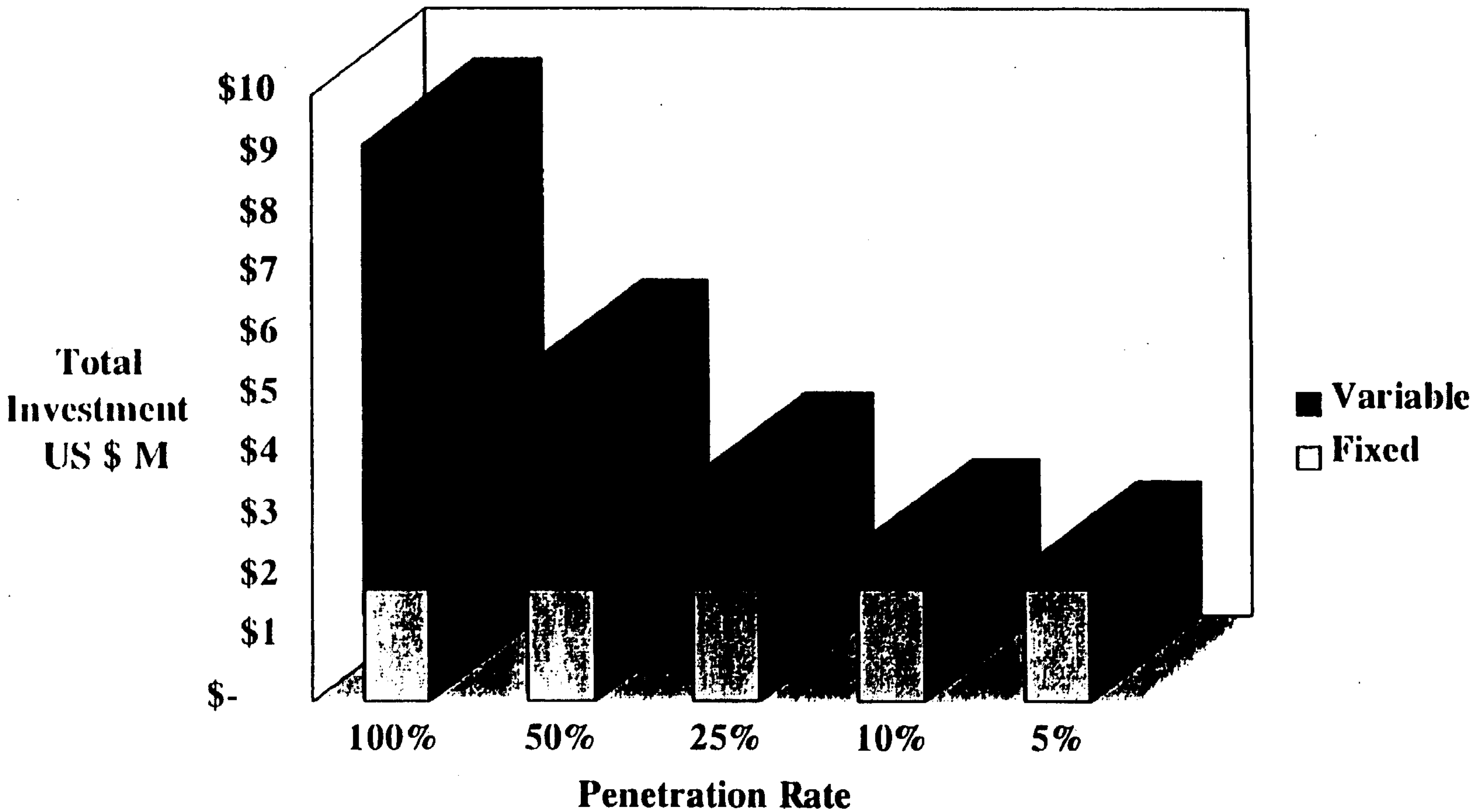
	Wireless	Wireline
CapEx/Sub (Year 10)	$ 560	$ 1,345
OpEx/Sub (Year 10)	$ 37	$ 240
Peak Funding (millions)	$ 1,169	$ 11,584
Payback Period	Year 3	Year 10 +
IRR	65%	5%
NPV/POP	$ 433	$ (309)

The analysis clearly shows the superior economic value for an operator from deploying an Enhanced cordless network over a standard wireline network.

Economics
U.S. Rural Case

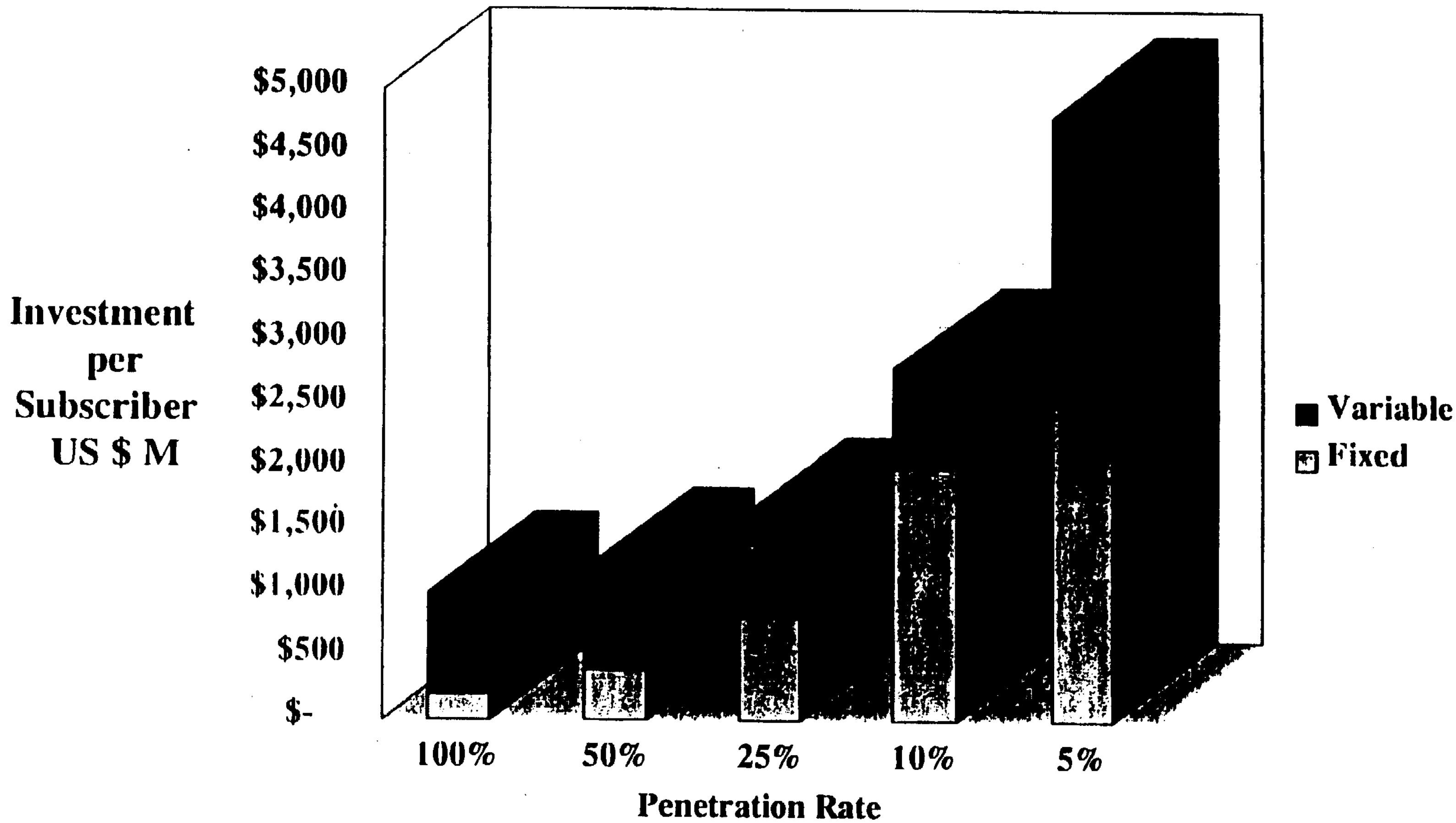
- Population density: 20 per sq. km
- Minutes of use per subscriber: 1,000 per month
- Wireline
  - twisted pair or cable telephony new build
  - Fixed costs: investment per inhabitant passed (feeder and distribution plant installed)
  - Variable costs: investment per customer connected (last mile drop wire and loop electronics installed)
- Wireless
  - WLL technology based on enhanced public cordless
  - Base station range: 12.1 km
  - Fixed subscriber terminal AC powered with battery backup

Economics
U.S. Rural Case- Wireline Telephony

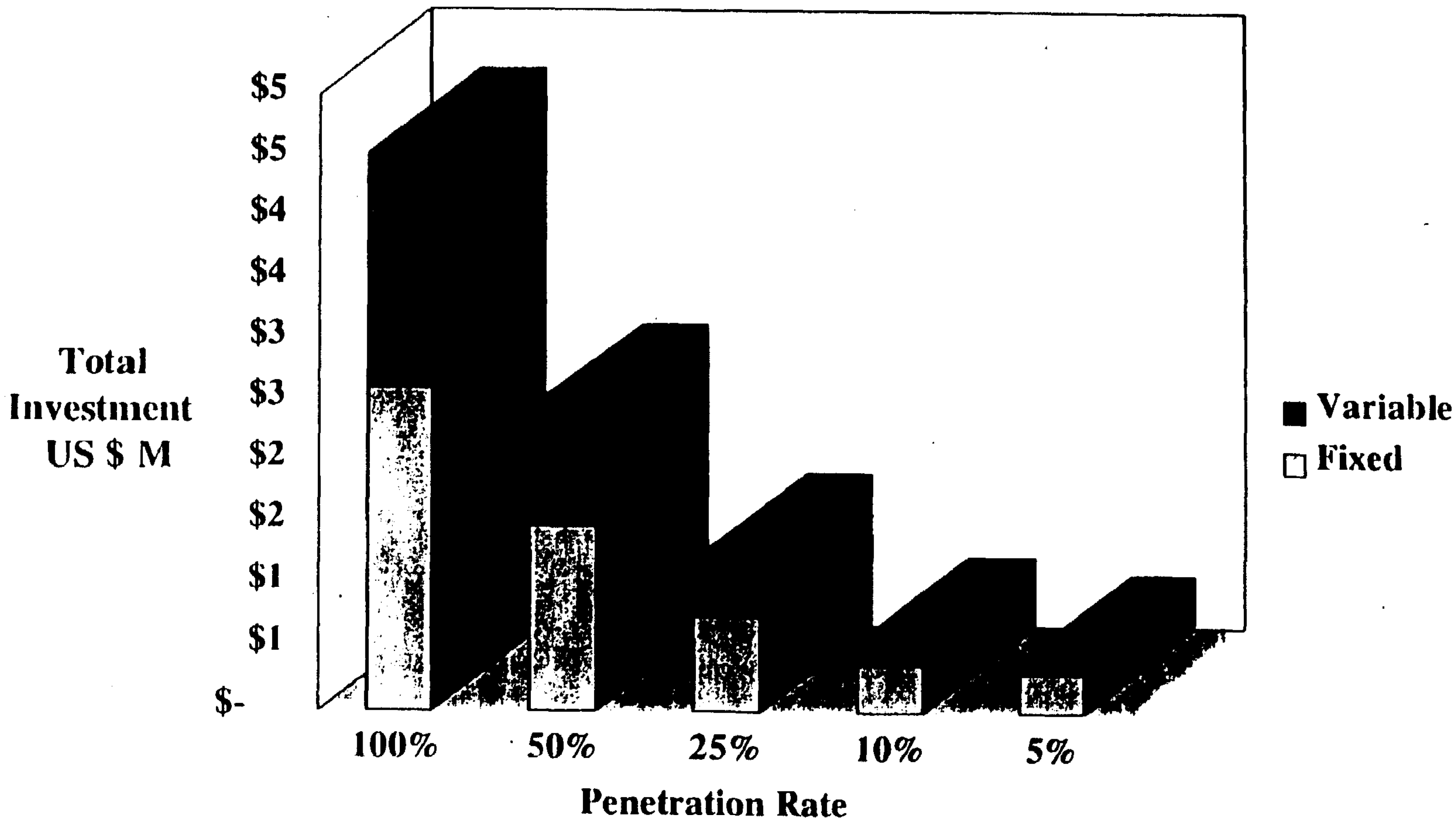


Economics

U.S. Rural Case- Wireline Telephony

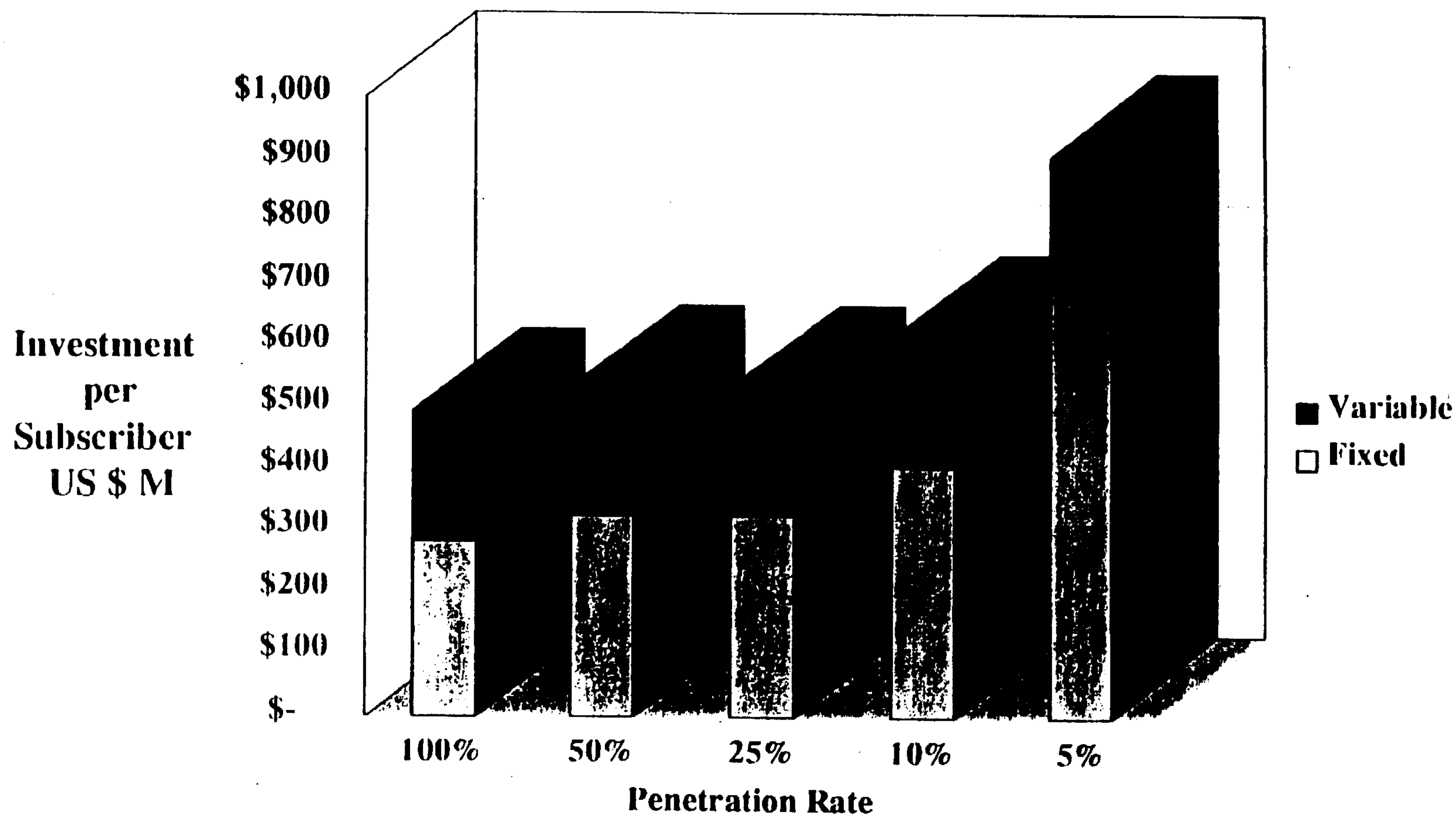


Economics
U.S. Rural Case - Enhanced Cordless WLL



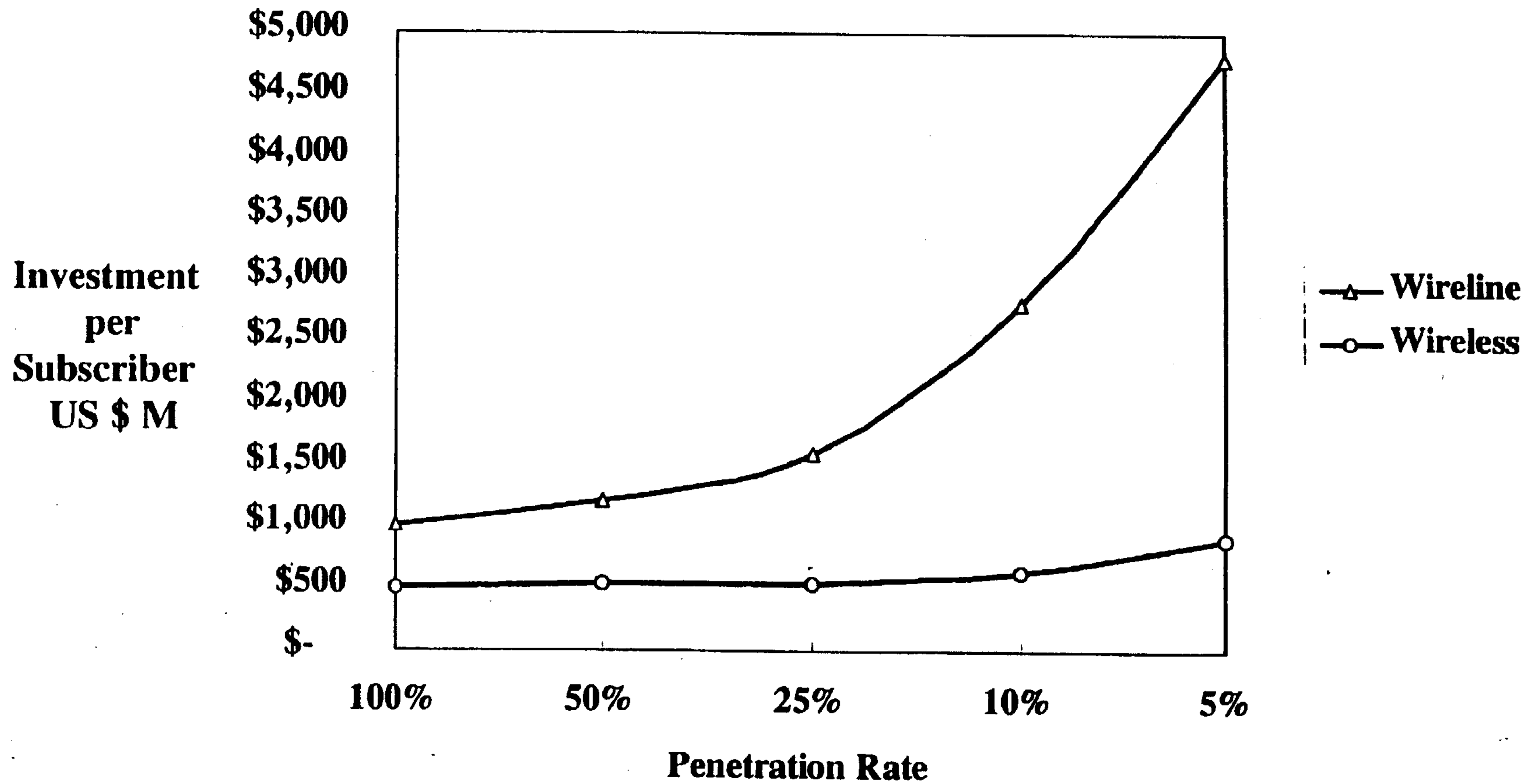
Economics

U.S. Rural Case - Enhanced Cordless WLL



Economics

U.S. Rural Case -(Sensitivity to Penetration Rates)



Economics
U.S. Rural Case - Summary

- Approximate investment per "home" passed
  - Wired: $800
  - WLL: $ 30

- Payback on capital investment@ 10% penetration

	$ 30/mo.	**$ 20/mo.** ← **Service Price**
Wired:	8 years	12 years
WLL:	2 years	3 years

- *Even in urban and suburban areas, McKinsey & Co. in their 1998 report, Breaking the Access Bottleneck, cites the following breakeven (net profit) penetration rates:*
  - *Twisted pair or Coax new build:* *30%*
  - *Fixed wireless new build:* *10%*

Economics
Summary

- Wide coverage (fewer sites for coverage)
- High capacity (fewer sites, less spectrum required)
- Faster deployment
  - Fewer sites
  - No frequency planning
  - Minimal antenna engineering
- Consistently high voice quality and data rates
- Low investment per subscriber
- Lower lifecycle costs
  - Less rent, utilities, maintenance expense
  - Less re-engineering for growth
  - Software upgradeability

Regulatory Policy Issues

Technology Implications

- Smart antennas reduce the cost of providing wireless services (cap-ex and op-ex)
  - lowering entry barrier to new operators
  - making possible all-inclusive, affordable services with inexpensive terminals
- Smart antennas enable useful applications in even limited allocations
  - especially important for certain new allocations below 3 GHz
  - gains are most significant with TDD